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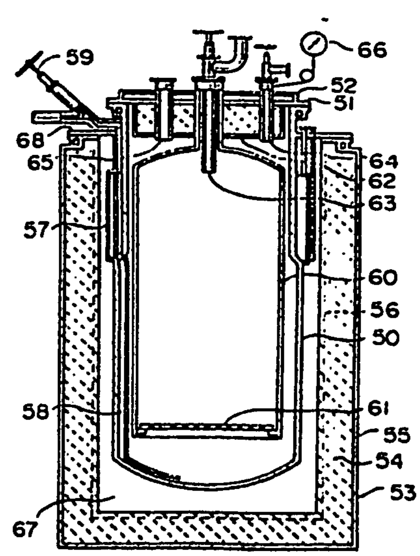
(54) Improvements in a method and an apparatus for producing titanium metal from titanium tetrachloride.

(57) In a method for producing titanium metal from tetrachloride which comprises holding magnesium as fused in a space which is provided within an elongated vessel means and is heatable with a furnace means to surround, introducing titanium tetrachloride onto said magnesium to cause a reaction therebetween to form titanium metal product and magnesium chloride byproduct, continuing such reaction until the vessel means is deposited with a substantial volume of titanium metal and recovering the metallic product and chl ride byproduct.

An improvement which essentially comprises providing an interspace airtightly sealed and pressure regulatable between the vessel means and the furnace means, and keeping said interspace at a pressure, with an inert gas, close to that inside the vessel means while the vessel is heated in the furnace.

FIG 1



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The present invention relates to improvements in a method and an apparatus for producing titanium metal by Kroll Process, in which titanium tetrachloride is reduced with fused magnesium.

Titanium metal is industrially produced generally by reduction of titanium tetrachloride with fused magnesium: $TiCl_4 + 2Mg \longrightarrow Ti + 2\ MgCl_2$ in which such tetrachloride is fed to the magnesium held in a crucible which is heatable with an openly surrounding furnace. During such process the crucible is subjected inside to a temperature of above 800°C as well as a positive pressure which is provided for blocking penetration of ambient air and is further raised to 1 kg/cm^2 (98 KPa) (by gauge) in many cases where magnesium chloride byproduct is tapped off as liquid during or at the end of reduction run. Thus such vessel to be used for this purpose must exhibit a mechanical strength enough to support the weight of both the contents and the vessel itself under a combined condition of such elevated temperatures and differential pressure. Although some heat resistant steel is available quite a thick wall must be necessarily provided to impart proper physical strength. Unfavorably in addition to the material being rather expensive. For example, when a vessel is made of a 13-Cr type stainless steel to measure 1.5 m in diameter and 4.5 m in length for a capacity of three tons of titanium product, the vessel weights as much as six

t ns with a wall thickness of 32 mm.

On the other hand, it is desired that such vessel be constructed to an enlarged capacity for improved production efficiency per batch; this is practically quite a difficult problem with conventional operation, since such enlarged vessel involves a further increased wall thickness, and as a result of thus increased weight, such plant equipment as hoists to transfer the vessel should be essentially provided with an increased capacity in accordance, as well. In addition, in communication between the reaction in the vessel and regulation outside, or temperature detection by means of thermometers placed on the outer face of the vessel and temperature control by cold air circulation on the vessel, thickened wall of rather heat inconductive material such as Cr-stainless steel unfavorably causes delay in both ways of sensing and controlling of temperature. Further even such thickened wall cannot be effective to a sufficiently extended service. Nickel alloyed steel is preferred because of improved heat resistance but is not applicable without a troublesome handling such as provision of a special lining thereon, since ingredient nickel is consumed as alloyed with magnesium during the process, otherwise. The material also is vulnerable to cracking due to inherent intergranular corrosion and thus involves a dangerous possibility to flow liquid contents out of the vessel.

For practice of the process, such an apparatus design as known, for example, German Patent Specification No. 1084923 is widely employed which basically comprises a cylindrical member with a closed bottom so as to hold liquid phase and another cylindrical member arranged therein and closed at a bottom with a detachable grid plate, the latter having a number of through holes therein so as to selectively support solid phase thereon. Titanium tetrachloride is supplied as either liuqid or vapor to a bath of fused magnesium held in vessels as filled initially to a level slightly over the grid plate, thus causing the reaction. Heavier than the liquid magnesium, titanium metal as well as magnesium chloride thus formed come down in the former, and the metal to a substantial part rests on the grid plate, while the chloride, on a bottom of the outer vessel. As the reaction proceeds, content in the vessels increase in mass so the magnesium has a surface level rising in accordance. In cases where the level rises too high, at which the reaction substantially takes place, magnesium chloride may be tapped off in some instances during such process at an interval so that the magnesium level is lowered, thus providing a useful space above the magnesium surface, when the reaction is resumed. Such cycle is continued until there is no more magnesium effectively available in the vessels. The introduction of titanium tetrachloride is also discontinued when the content in the vessels has

a surfac lev l at or over a predetermined upp r limit. The metallic reducing agent is in some cases replenished after the chloride byproduct is removed when the metal has been consumed up, especially in cases where the vessels are of a design to provide rather a small space within. Anyway by such conventional techniques whereby the reaction is caused at a varying magnesium level up starting from a position only a little above the bottom plate, resulting titanium tends to deposit as hollow bulk full of closed large cavities within, thus blocking some part of molten magnesium to come out to the surface for reaction, and achieved magnesium efficiency is inevitably low.

On the other hand, or more important than the above, since such reaction is controlled as said above, usually on temperature measurement of a reaction zone (one in a vicinity of the magnesium surface as fused) by means of thermometers placed at different height levels on an outer face of the outer vessel. Since an excessively elevated temperature of a region adjacent to the vessel wall causes contamination of the metallic product deposited thereon by alloying with wall material to result in a poor product purity achieved, and since the reaction is of an exothermic nature, the region is essentially controlled so that a temperature may be maintained in this circumferential region securely below an alloying point between the two materials, by moderately feeding titanium tetrachloride

or by cooling the zone from outside the vessels. In the former case, attainable operation rate inevitably remains low, while in the latter case, however, a proper regulation for the reaction is fairly a tough task because of a varying magnesium surface level where the reaction takes place, which cannot be precisely detectable and follow up exactly with such insensitive technique as generally employed temperature measurement through thick vessel walls.

Another technique, as published in U.S. Patent No. 3,150,671 to Socci, is known for titanium production from the tetrachloride, whereby the tetrachloride and magnesium are alternately introduced in an inner cylindrical vessel which is enveloped in another cylindrical vessel and has a wall full of tiny through holes of a specific dimension. Allowing to selectively removing magnesium chloride byproduct from magnesium reducing agent through such specific holes as well as such alternating small batch feed of reactants, it is described, the process permits an improved magnesium efficiency as well as a regular reaction rate to be achived. However, it is observed, disadvantageously, that the technique requires such rather sophisticated and costly means as injection of fused magnesium as well as special holes in the vessel wall which seemingly tend to change in size or, clogged partially or at worst ntirely with finely divided titanium solid formed by the reaction.

Still another apparatus construction is known from U.S. Patent No. 3,684,264 to Ivanovich Petrov. et al. The chloride reduction section comprised in such apparatus, in contrast, is of a single cylinder construction, though. Titanium tetrachloride is reduced and titanium metal is deposited in the sole vessel. This means requirement of a troublesome treatment for discharging the contents, in comparision with the first mentioned vessel construction where a second cylindrical vessel is employed to receive the product, and thus the content is readily removable out of the apparatus by separating the vessels and by pushing the contents with a suitable mechanical means.

Therefore, an objective of the present invention is to provide improved methods for production of titanium metal by chloride reduction with magnesium, which are substantially free of above said drawbacks.

Another objective of the invention is to provide an improved apparatus to effectively put such methods in practice.

According to the invention there is provided, first a method for producing titanium metal from titanium tetrachloride which comprises holding magnesium as fused in a space which is provided within an elongated vessel and is heatable with a furnace surrounding the former, introducing titanium tetrachloride onto said magnesium to cause a reaction therebetween to form a titanium m tal product

and a magnesium chloride byproduct, continuing such reaction until there is a substantial volume of titanium metal deposit on a supporting member in the vessel, and recovering the product and byproduct, characterized by that the magnesium is initially loaded to a quantity to exhibit the level substantially distant above from the supporting member, then the supply of the tetrachloride is started, thus allowing thus formed particles of titanium metal to move down in the liquid over a substantial distance until they are supported by the member, and the magnesium level is maintained within a limited range of the initial height by discharging the byproduct as fused so as to compensate the level rise to an extent large enough to make a room thereover effective for further reaction, while the temperature condition is specially regulated over said range.

Although such methods may be conducted with conventional arrangements of some types directed to a similar production of titanium metal, they are preferably performed with an apparatus, according to the invention, for producing titanium metal by reduction of titanium tetrachloride with fused magnesium which apparatus comprises: a cylindrical outer vessel which has a top closed with a detachable lid, a furnace which is so arranged as to enclose a substantial part of the vessel upwards from a bottom thereof, a cylindrical inner vessel which has

at p a tube for introducing titanium tetrachloride and at a bottom thereof a detachable plate riddled with through houles so as to receive a downcoming solid product of titanium metal but to allow to pass through a liquid by-product of magnesium chloride as well as magnesium metal as fused, and a duct which extends into the outer vessel for discharging the byproduct, characterized by that said outer vessel being provided thereon with a cooling jacket at an upper portion of the inner vessel which is joined to the lid with a separable joint, and said inter-space is sealed airtightly so as to be pressure regulatable.

In the invention the reaction byproduct, or magnesium dichloride, as fused is discharged in part from the vessel or vessels continuously or intermittently through a duct which extends into the sole or outer vessel and is open in a bottom portion thereof. Thus magnesium surface level is maintained within such a range of the initial level that an effective room is secured over the magnesium surface for further reaction to take place while a substantial vertical distance is maintained from the bottom grid plate. Such distance varies dependently on vessel capacity, but it would be convinient to say that the magnesium level be held above a two-thirds or threee-quarters the axial length of the outer vessel apart from the grid plate. The v ss l is cooled from outside in some ways. A cylindrical jacket, which is attached to the

outside face of the outer vessel and through which cold air is circulated, is inexpensive to construct and easy to access while working effectively.

In a preferred practice of the method an airtightly sealed closed space (referred as "interspace" in this specification) is provided between the vessel and furnace, usually sealed at a flange portion with a heat resistant packing. Such an inert gas as argon is filled in the interspace. As the furnace is actuated and as the reaction proceeds inside the vessel, pressure varies inside and outside the vessel, so regulation becomes necessary to maintain a differential pressure, either positive or negative within a given range, preferably of 0.2 kg/cm² (19.6 KPa). The closer to zero, the better. Thus substantially unloaded of stresses due to such differential pressure which are significant at such elevated temperatures where the reaction takes place, the vessel may consist of carbon steel of some grades, which has been heretofore considered ineffective to this application due to inherent insufficient mechanical strength at elevated temperature, in the place of conventionally employed rather expensive stainless steels. Or alternatively, a possibility is provided by the invention to readily construct a vessel for the process of a substantially increased capacity. The vessel of the present invention advantageously take a double-cylindrical construction.

As taken out of the furnace, the inner cylindrical vessel is detached from the lid for discharging reaction products and for charging fresh magnesium metal. Connection between the lid and the vessel can be realized in various ways. In an example, the vessel is in a hanging arrangement from the lid through a rather thin tubular body (bottle neck) which is cut to disassemble and welded to unite; or an inner vessel of generally straight cylindrical construction is fixed to the lid by means of several bolts running through the lid into a rather thick walled top adge of the vessel, said bolts being preferably forcibly cooled at the head. An additional mechanical coupling may be provided for a facilitated positioning and secured tightness. For this purpose the mating faces of the lid and vessel may have a circular tenon and a groove to fitly accomodate it, each on either side. In another case the lid has a rather short cylindrical skirt with which the vessel is put in a close telescopic connection, with either placed on outside. Further, such bolting and the secondary coupling means can be replaced by a so-called bayonet connection, by which several pins or claws attached to the lid are put in respective L-shape small slots and then revolved relatively to the vessel slightly to a stop, thus providing a secured fixation.

Other features of the invention and effects attained

thereby will be better understood from the following description taken in connection with the accompanying drawing which is given for illustrative purpose only, and not for limiting the invention. Of which drawing,

Figure 1 illustrates an elevational view, in section, of an apparatus constructed according to the invention and suitably applicable to the method of the invention, and

Figure 2 schematically shows at (a) to (c) a detailed view of a few variations for connection between the inner vessel and the top lid.

A substantially cylindrical outer vessel 50 in Figure 1 has detachable lid 51, whichis airtightly sealable and has thereon a cooling jacket 52, and is placed inside an electrical furnace 53 comprising a refractory wall 54 coated with an iron shell 55 thereon outside and on an inside face thereof a heating element 56 which is di-visively regulatable in several sections. The outer vessel 50, especially in this example, comprises in a cylindrical wall thereof, over at an upper portion a cylindrical jacket 57, for cooling by a circulation of cold air therethrough, as well as a duct 56, with a valve 59 thereon, extending into the vessel at a bottom end for discharging magnesium chloride byproduct as fused. Inside the vessel 50 in a hanging joint from the lid 51 by means of a neck member of tubular body, there is provided a substantially cylindrical inner vessel 60 which has a

grid plate 61 detachably attached at the open bottom for receiving a downcoming solid product of titanium metal while allowing to pass such liquids as magnesium metal and magnesium chloride. The neck member is cut for separating and to be connected by welding for rejoining the inner vessel with the lid. The cooling jacket 57 and the grid plate 61 are arranged at a substantial vertical space therebetween.

For a facilitated separating and uniting of the inner vessel and the lid as well as secured close connection, the inner vessel 60 in this example is joined with the lid 51 by means of several threaded bolts 32 run into a top portion having a rather thickened wall of the vessel as better seen in Figure 2 at (a) and (b), simultaneously with an auxiliary mechanical coupling, such as a circular tenon 33 to be mated with a circular groove 34 to fitly accomodate the former. In the place of such tenon-groove coupling, a telescopic connection may also be employed which consists of a rather short cylindrical skirt or ring 35 attached to the lid as hanging therefrom and having such dimensions as to be fitly and closely connected with the vessel. The bolts preferably have a top end covered with respective cap nuts 36 which are advantageously water cooled.

As a substitute for the bolts and coupling joint, a so-called bayonet connection is also effective (giv n

schematically in Figure 2 at (c), particularly), by which several hooked claws 37 attached to the lid, in a circular arrangement, are put into L-shaped slots 38 so formed as to mate with each claw at a top end of the vessel 60, and then the members 25, 60 are pushed close until they are in a close contact and slightly revolved realtive to each other to a stop, thus providing a secured connection between the lid and the vessel. It is obvious here that a small modification may be effectively made, within the scope of the invention, to the above listed joints between the inner vessel and the lid.

The lid 51 has a can 62, packed with a suitable heat insulative substance and, preferably, provided therein with a heating element (not shown) for preventing solidification of magnesium metal on a can surface which results in purity trouble on the metallic product. A tube 63 and tubes 64 and 65 with a pressure indicator 66, each arranged to extend through the lid 51 and into and outside the inner vessel 60, are used to feed titanium tetrachloride as well as to supply inert gas and to degas for bleeding or evacuating the vessels 50, 60. Although not illustrated in particular, a closed interspace 67 is formed between the outer vessel 50 and the furnace 53, airtightly sealed with a heat resistant packing ring provided between a flange portion 68 and the furnace 53, the space being pressure regulatabl by means of inlet and outlet tubes

and a pressure indicator, connected with a source of an inert gas.

When required, a duct (not shown) also may be provided for supplying magnesium metal in fused state to the inner vessel 60 for an extended operation period.

Example 1

An apparatus substantially illustrated in Figure 1 was used, which comprised a SUS 410 grade (by JIS Designation) inner vessel which measured 1.6 m in I.D. and 19mm in wall thickness, and a SUS 316 grade stainless steel outer vessel which measured 4.5 m in general length, 1.7 m in I.D. and 32 mm in wall thickness and had a cylindrical jacket over a range of about 2 to 3 m from the bottom end of the inner vessel. A furnace was cylindrical and measured 2.5 m in O.D. and 5 m in length with an iron shell tightly covering thereover. Heating element was divisively regulatable at an upper section adjacent to the cooling jacket. The inner vessel as disassembled was charged with about 7.8 tons of magnesium as ingots, which is calculated to give a bath surface level of approximately 2.3 meters and 3 meters from the bottom of the inner and outer vessels, respectively. With the vessels assembled as set in the furnace, and with the interspace, between the outer vessel and the furnace, filled with argon gas, the vessel were heated to approximately 800°C to melt the magnesium contained therein, onto which titanium t trachloride was

introduced at a rate of 400 kg/h through a tube atop the vessels. On estimated magnesium level from a total amount of supplied chloride and from differential pressure between inside and outside the outer vessel, liquid was tapped off from the vessels through a duct intermittently every three hours starting after initial six hours of chloride introduction. Power supply was discontinued to the furnace intermittently at an upper section adjacent to the jacket, where cold air was circulated through, so that the upper region was maintained at a temperature of not in excess of 950°C, thus minimizing contamination of metallic product by vessel material, while the rest of the vessel space was maintained at about 800°C. as measured on the outer vessel, for an easy removal of the liquid byproduct. Differential pressure was so regulated that level in the interspace was noway in excess of 0.6 Kg/cm² (58.8 KPa) and within 0.2 Kg/cm² (19.6 KPa), either positively or negatively, from the level in the vessels, as in antecedent examples. As a result of the above cycle, which was continued for 50 hours in total, the inner vessel was taken out to deliver some 5.1 tons of titanium sponge. This consists a substantial improvement over conventional operations, which on an average produces titanium metal at a rate of approximately four tons 70 hour-cycle with the inside vessel space occupied of only 70% at best.

As may be understood from the above description,

the invention.

I. whereby the chemical reaction is caused between titanium tetrachloride and magnesium at a substantially limited range of the bath level, vertically distant from the level where titanium metal is received, permits:

1. a significant improvement to be achieved in product yield or quality as well as production rate at the same time, as a result of effectively regulatable temperature condition of the reaction zone, so that titanium tetrachloride can be supplied at a raised rate without increasing possibility of contamination by overheated vessel material of nearby deposited metal,

2. production of titanium metal of a regularly favorable chemical and mechanical quality at an improved yield, as a result of the reaction conductable with titanium tetrachloride supplied at a regular rate throughout the cycle, and

3. titanium metal deposit to be obtained in a favorable accumulation which is free of large cavities within, which are often observed when treated by a conventional technique whereby magnesium surface rises from an initial level close to a bottom plate to rest the metal, and which causes abnormally accelerated rise of such bath level to terminate the reaction with much magnesium metal unconsumed; and

II. whereby the vessel to be us d in adjacency to the

furnace is substantially removed of stresses due to differential pressure between inside and outside the vessel during operation, permits:

1. a substantial improvement to be achieved in plant economy as a result of now available carbon steel of some grade even at a decreased wall thickness, so the apparatus can be constructed less expensively and, accordingly, equipments of smaller capacity is required for handling or alternatively, with a substantially decreased wall thickness available, vessel construction of enlarged dimension can be readily realized for an improved production efficiency per batch;

2. production of an improved quality at a substantially reduced cost as a result of increased mass of titanium tetrachloride treatable per batch, and as a result of the reaction to form titanium metal now controllable at a raised precision due to an improved communication between the reaction and regulation;

3. a considerably extended service life of the vessel member as a combined result of (a) exposure outside to an inert gas atmosphere so as to effectively eliminate deterioration by oxidation, (b) an essentially removed stress cracking which inevitably occurs in the case of alloyed steel heretofore employed, (c) avoided consumption of v ssel material by magn sium or other reaction mat rials as in the case of Ni-alloy d st el, the nick l forming an

alloy with magnesium to be dissolved in the bath, and (d) an effectively prevented geometrical deformation of the vessel by maintaining the differential pressure at a level within the specific range herein given; and

4. a secured safety provided for operators in case of accidental cracking of the vessel, because the possibility has been substantially reduced for the liquid contents to flow outside the furnace since the latter has a tight wall construction with an iron shell thereon.

CLAIMS:

1. A method for producing titanium metal from titanium tetrachloride which comprises: holding magnesium as fused in a space, which is provided within an elongated vessel and which is heatable with a furnace surrounding the vessel, introducing the tetrachloride onto the magnesium to cause a reaction therebetween to form a titanium metal product and a magnesium chloride byproduct, continuing such reaction until there is a substantial volume of titanium metal deposit on a supporting member in the vessel, and recovering the product and byproduct, characterized by that the magnesium is initially loaded to a quantity to exhibit the level substantially distant above from the supporting member, then the supply of the tetrachloride is started, thus allowing thus formed particles of titanium metal to move down in the liquid over a substantial distance until they are supported by the member, and the magnesium level is maintained within a limited range of the initial height by discharging the byproduct as fused so as to compensate the level rise to an extent large enough to make a room thereover effective for further reaction, while the temperature condition is specially regulated over said range.

2. A method as claimed in Claim 1, characterized thereby that said byproduct is discharged intermittently.

3. A method as claimed in Claim 1, characterized thereby that said byproduct is discharged continuously.

4. A method as claimed in Claim 1, characterized thereby that an airtightly sealed and pressure regulatable interspace (67) is provided between said vessel (50) and said furnace (54), and the interspace is kept at a pressure, with an inert gas, close to that inside the vessel while heated.

5. A method as claimed in Claim 4, characterized thereby that the pressure in the interspace (67) is kept within ± 0.2 Kg/cm^2 (19.6 KPa) of that inside the vessel space.

6. A method as claimed in Claim 4, characterized thereby that the pressure in the interspace (67) is kept lower than that inside the vessel space.

7. A method as claimed in Claim 4, characterized thereby that the pressure in the interspace (67) is kept higher than that inside the vessel space.

8. A method as claimed in Claim 4, characterized thereby that the pressure in the interspace (67) is kept substantially identical to that inside the vessel space.

9. A m thod as claimed in Claim 4, characterized thereby that the inert gas substantially comprises argon.

10. An apparatus for producing titanium metal by the reduction of titanium tetrachloride with fused magnesium, which apparatus comprises: a cylindrical outer vessel which has a top closed with a detachable lid, a furnace so arranged as to enclose a substantial part of the vessel upwards from the bottom and a cylindrical inner vessel which atop has a tube means for introducing titanium tetrachloride and at a bottom thereof a detachable plate riddled with through holes so as to receive a solid product of titanium metal selectively from a liquid byproduct of magnesium chloride as well as magnesium metal as fused, and a duct arranged into the outer vessel for discharging the byproduct, characterized thereby that said outer vessel (50) is provided thereon with a cooling jacket (57) covering an upper portion of the inner vessel (60) which is joined to the lid (51) with a separable joint, and said interspace (67) is sealed airtightly so as to be pressure regulatable.

11. An apparatus as claimed in Claim 10, characterized thereby that said cooling jacket (57) is provided as substantially spaced from the height of the bottom plate (61).

12. An apparatus as claimed in Claim 10, characterized thereby that said inner vessel (60) is in a welded connection with a tubular body which is attached to the lid (51).

13. An apparatus as claimed in Claim 10, characterized thereby that said inner vessel (30) is in a detachable engagement with the lid (22) by a mechanical means (32; 33; 34; 35; 37; 38).

14. An apparatus as claimed in Claim 13, characterized thereby that said mechanical means substastially consists of several hooked claws (37) attached to the lid (22) and L-shaped slots (38) formed in a top portion of the vessel (30) to receive the claws (37) and to be fixed by a slight relative revolution between the vessel (30) and the lid (22).

15. An apparatus as claimed in Claim 13, characterized thereby that said mechanical means comprises bolting (32) as well as an auxiliary coupling (33; 34; 35) for a secured and facilitated assembly.

16. An apparatus as claimed in Claim 15, characterized thereby that said auxiliary coupling substantially consists of a circular groove (34) on the lid such as to fitly accomodate a top portion (33) of the inner vessel to be mated.

17. An apparatus as claimed in Claim 13, characterized thereby that said auxiliary coupling substantially consists of rather a short cylindrical skirt (35) attached to the lid (22), which has an inside or outside dimension to fitly accomodate a top porti n of the inner vessel to be mated in a telescopic manner.

FIG 1

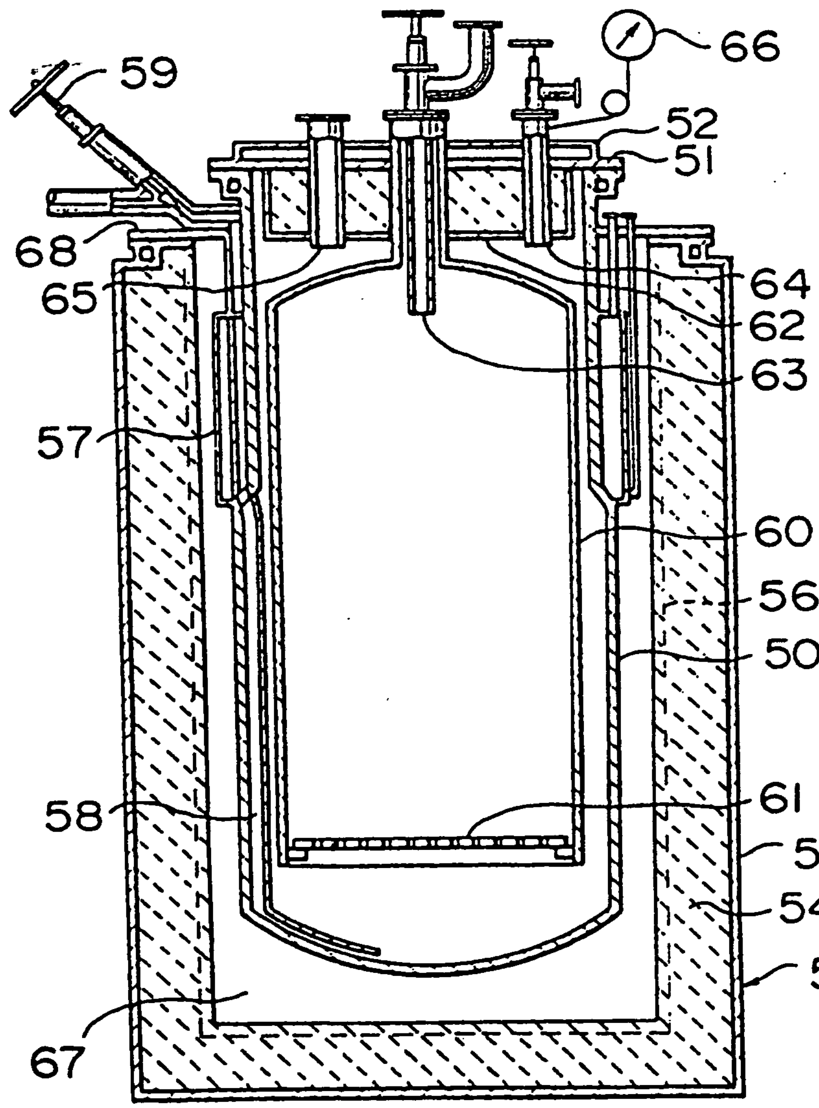


FIG 2a

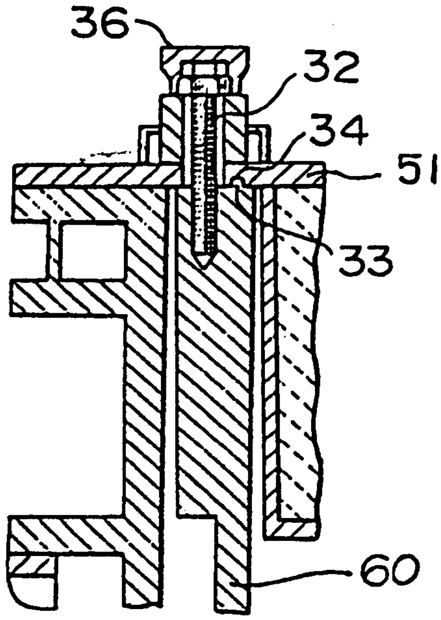


FIG 2b

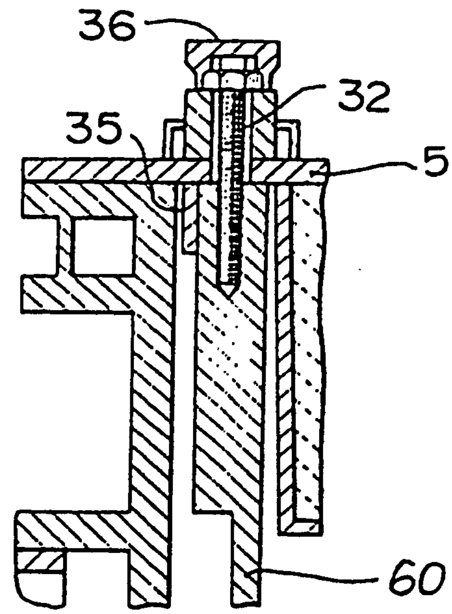
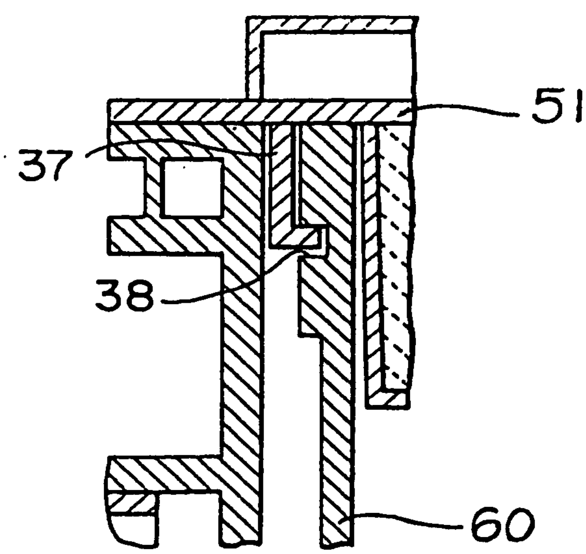


FIG 2c



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EUROPEAN SEARCH REPORT

0160779

Application number

EP 85 10 0932

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
Y	US-A-2 787 539 (CONKLIN) * Columns 3, 4 * ---	1	C 22 B 34/12
Y	DE-C-1 124 247 (FEMIPARI KUTATO INTEZET) * Columns 3, 4 * ---	1	
Y	DE-U-1 796 728 (HERDIECKERHOFF) * Pages 4, 5 * ---	4	
Y	DE-B-1 094 718 (CIBA) * Column 4 * ---	4	
A,D	US-A-3 158 671 (SOCCI) ---		TECHNICAL FIELDS SEARCHED (Int. Cl.4)
A,D	US-A-3 684 264 (PETROV et al.) ---		C 22 B 34/12
A,D	DE-C-1 084 923 (ISHIZUKA) ---		
A	US-A-2 586 134 (WINTER) ---		
A	US-A-2 763 480 (KELLER et al.) --- -/-		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	15-07-1985	SUTOR W

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-3 692 294 (ISHIMATSU et al.) -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

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